

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
17 October 2002 (17.10.2002)

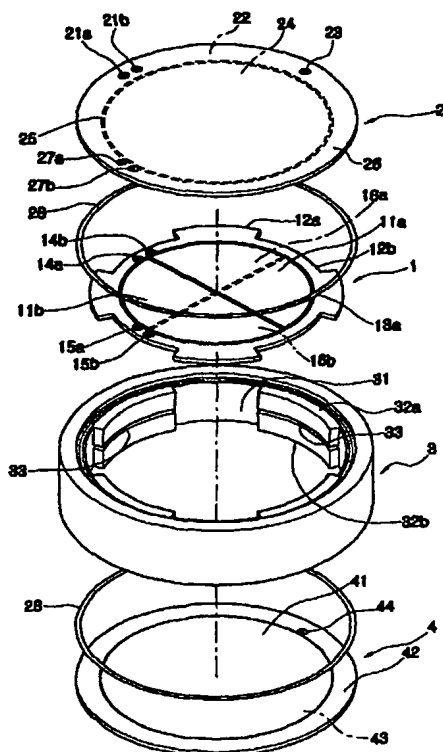
PCT

(10) International Publication Number
WO 02/082017 A1

- (51) International Patent Classification⁷: G01C 9/18
- (21) International Application Number: PCT/KR02/00618
- (22) International Filing Date: 9 April 2002 (09.04.2002)
- (25) Filing Language: Korean
- (26) Publication Language: English
- (30) Priority Data:
2001/18784 9 April 2001 (09.04.2001) KR
- (71) Applicants (for all designated States except US): KOREA RESEARCH INSTITUTE OF STANDARDS AND SCIENCE [KR/KR]; 1, Doryong-dong, Ryusung-ku, Daejeon-city 305-340 (KR). APPLIED CAPACITANCE CORPORATION [KR/KR]; 366-18, Songnae-dong, Sosa-ku, Bucheon-city 422-041 (KR).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): LEE, Rae-Duk [KR/KR]; 110-402, Hanbit Apt., Ueoeun-dong, Ryuseong-ku, Daejeon-city 305-755 (KR).
- (74) Agents: LEE, Young-Kyu et al.; Young-Kyu Lee Patent and Law Office, 2nd Fl., Namdo Bldg., 823-24, Yeoksam-dong, Kangnam-ku, Seoul 135-081 (KR).
- (81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.

[Continued on next page]

(54) Title: CAPACITYIVE SENSOR FOR MEASURING OF INCLINATION



(57) Abstract: This invention relates to a capacity sensor for measuring of inclination wherein such an inside electrode plate that it has guard-ring electrode in the circumference and also forms each couple of semicircular type inside electrode symmetrically in the front and rear of printing circuit plate is fixed to the center of metal ring for supporting an electrode, and an outside electrode having a guarding electrode in the circumference is placed against the inside electrode as such and also it is separated and fixed by designated distance for the inside electrode plate both sides of metal ring for supporting an electrode thereafter, the sensor structure is comprised by pouring liquid transmission display between inside electrode plate and outside electrode plate, and inside electrode and outside electrode is separated into a couple because liquid transmission display caused by inclination of the sensor is flown, whereby it can be measured an inclination on a basis of the change of electricity capacity between inside electrode and outside electrode.

WO 02/082017 A1



(84) **Designated States (regional):** ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Published:

— with international search report

Capacitive sensor for measuring of inclination

Technical Field

5 The present invention relates to a sensor of which is possible to measure the horizontal state or the inclination of the apparatus and structure, etc, and more particularly, of which is possible to measure the inclination on the basis of the changes of the electrode area that the liquid dielectric is contacted between inner electrode and outer electrode by the inclination since the sensor
10 is composed by pouring the dielectric between the inner electrode that is divided into a couple and the outside electrode that is faced with the inner electrode.

 If the horizontal state of apparatus or structure or the state of inclination is exactly measured, the applicable field is very abroad. There is such a simple
15 category that the horizontal state of the plate or mechanism can be simply measured, or the horizontal or vertical state of a building can be simply measured but it is necessary to maintain always any angle for the structure, and also every kind of industrial field have been becoming very variously, highly and precisely. Also, the field for measuring of the inclination state of the apparatus
20 or structure that is possible to change at any time is continuously increasing. At this time, if the sensor exists for changing the result that the inclination is measured into the electronic signal, it will be very usefully used.

Background Art

In the prior method that has been used to measure the horizontal state of objects for measuring, it has been using such a principle that the positions of water-drop are changed according to the inclination by inputting the water-drop into inner portion of glass tube. The prior water-drop type inclination sensor has very important problems that the first, it can be used for measuring of the horizontal or vertical state but cannot be used for measuring of any angle as the numerical value precisely. The second, it is insufficient in the place that it has an object to measure correctly because the water-drop is expanded or shrunk by the temperature around of circumference. The third, it is difficult to control remotely or to monitor always because the electrical signal cannot come out. Recently, the precision tube that the position is changed into X and Y directions according to the inclination as it is connected to the fixing ball through the connecting road and the capacitive sensor for measuring of inclination (Korean Utility Model No. 1999-288442) that is possible to measure the angle of two dimensions by measuring of the electric capacity between four electrodes that is fixed to the circumference have been published. It is possible to measure the inclination greater than the mechanical stopping friction of the precision tube in the definite limits of an angle that are permitted to the electric portion of circumference by the sensor but it had been impossible to measure another angle. Especially, it had been impossible to sense the minute change of angle

because of the stopping friction.

Also, the electronic level (Korean Patent Appln. No. 1987-0005237) of the method for measuring of the electric resistance and impedance between two electrodes because of the inclination electrolysis nucleus existing to glass
5 instrument has been published, but it is possible to measure the horizontal and vertical states but it is impossible to measure the voluntary angle of the limits of $0^{\circ} \sim 90^{\circ}$ degrees into the numerical value.

Recently, in U.S.A., etc, the inclination sensor (U.S. Patent No. 6,032,375) equipping with the electric capacity type sensor and the water-drop
10 type sensor, the mechanical inclination sensor using the gravitation of weight (U.S. Patent No. 6,073,356), and the inclination sensor using the electric resistance of the liquid in the inside of an instrument (U.S. Patent No.6,023,971), etc. were developed and also the demerits of those are same as stated in above.

15 Also, multi-electrode electric capacity type inclination sensor (U.S. Patent No. 4,912,662) has been manufacturing and producing for the level use. But the said sensor was forming into the two-terminals type electric capacity apparatus because the metal capacity which the liquid has been putting was operated into an electrode for composing of the electric capacitor and it is very
20 sensitive by the circumference temperature because the volatile alcohol as the liquid dielectric substance was used, and if the conductance balance circuit is not separately used for the electric capacity that is possible to measure the

circuit because the characteristics of demerit coefficient are bad, it becomes to be difficult to measure the stable electric capacity.

On the other hands, the angle detector (U.S. Patent No.5,802,728) for fixing of the electrode that is faced with a couple of electrode as semicircular type to the circuit substrate in both sides of the ring for supporting that is manufactured into the PVC by the adhesive has been published. This is to consider only an electrode that is formed by the single electric capacitor but to disregard the voltage regulator shielding, and also the measuring stability of the electric capacity is bad because it is the two-terminals type electric capacitor using the volatile dielectric substance but the measuring angle and the linear angle are not studied. Also, there are such the possibilities that an amount of the liquid is reduced or it is highly affected by the change of the temperature after using of it for a long time because it is to use the liquid dielectric that the volatility is very high.

As mentioned in above, for the development of the sensor to measure the inclination, the methods that the mechanical gravitation of the weight is used or that the impedance of an electrolytic solution is measured, and also such the basic methods that the differences of electric capacity are measured are already known well. But, it is necessary to such the studies for finding out of how to compose of the electrode of electric capacitor and how to apply with the voltage regulator shielding and how to compose of a balanced three-terminals type electric capacitor and how to obtain of the output that the linear angle is

excellent.

Summary of the Invention

5 It is an object of the present invention to provide with the capacitive sensor for measuring of the inclination that the inclination of the apparatus or structure, etc that is based on the change of electric capacity between the inside electrode and the outside electrode by the flow of the liquid dielectric according to the inclination can be measured by the sensor of which is
10 composed as a couple of semicircular type inner electrode and the outer electrode that is faced with the inner electrode and the liquid dielectric having the most suitable characteristics, and further object of the present invention to provide with the capacitive sensor for measuring of inclination that the inclination of the apparatus and structure, etc. can be measured more correctly
15 and widely by dividing the inside electrode of both faces that is formed to the electrode plates which are directly crossed from each other and which are Included to the inclination sensor, and also to provide with the capacitive sensor for measuring of inclination that it can be possible to measure correctly the inclination of apparatus or structure, etc. because the electric capacity between
20 the inside electrode and the outside electrode is measured by intercepting of the changing factors of an electromagnetism noise or an electric field being which is added to the outside completely, and also that it can be possible to

display into an analog or the digital by changing a size of the inclination of apparatus or structure, etc. into the change of the electric capacity.

To achieve the object of the present invention, there is provided with the metal ring for supporting of electrode having cylinder shape and the
5 semicircular type electrode of which is contacted with said the metal ring for supporting of electrode, of which is divided into each a couple to the both faces and the inside electrode plate having the guard-ring electrode, and the outside electrode having the diameter of which is identify with the inside electrode and the guard-ring electrode that is fixed each to the both faces of said metal ring for
10 supporting electrode, that is formed to the inside face of the circuit substrate, and the sensor including with the liquid dielectric that is poured into the space between the inside electrode and the outside electrode that is sealed by the outside electrode plate having the grounding electrode for the voltage regulator shielding that is formed to the outside.

15

Best type for the Preferred Embodiments

The present invention has such the characteristics that it is possible to measure the inclination of apparatus or structure, etc. of which is based on the
20 change of the electric capacity between the inside electrode and the outside electrode by the change of the contact area of outside electrode that is faced with the inside electrode that is divided into two by flowing of the liquid dielectric

because of the inclination of sensor.

It is desirable that there is the state that the inclination of $0^{\circ} \sim 90^{\circ}$ degrees is measured by the inside electrode of one side of said inside electrode plate and one of out side electrode that is facing with the inside electrode and it
5 can be possible to measure the inclination of $90^{\circ} \sim 180^{\circ}$ degrees by the inside electrode of the others face of said inside electrode plate and the others outside electrode that is facing with the inside electrode because the inside electrodes of both faces of said inside electrode plate are directly crossed and divided from each other.

10 Also, if the inside electrode of both faces of the inside electrode plate are symmetric and divided to be corresponded from each other, the inside electrode of both faces of said inside electrode plate will be contacted to be lined up with each other, therefore, it is desirable to increase the measuring sensitivity in duplication because it is possible to measure the inclination of 0°
15 $\sim 90^{\circ}$ degrees in duplication.

Also, it is desirable to combine the inside electrode plate with the metal ring for supporting of electrode that a plurality of irregularities portion are formed to the outer circumference face of said inside electrode plate, and the designated space is formed for moving of said liquid dielectric between said
20 metal ring for supporting of the electrode and the essential part of inside electrode plate. And, it is desirable to manufacture that the guard ring electrode of inside electrode of which is formed to both faces of said inside electrode plate

is put to the center portion of the metal ring for supporting of the electrode and then is grounded automatically, and also it is desirable to manufacture for forming of the voltage shielding structure having the complete ground power source because it becomes to be completely contacted with the guard-ring of
5 outside electrode and the metal ring for supporting of the electrode and it becomes to be completely contacted and fixed with the electrode for the outside shielding by attaching of the guard ring electrode of said outside electrode to both faces of the metal ring for supporting of the electrode with the O-ring and by rebooting of the thin metal band that is manufactured to the end edge of the
10 circumference of a circle over the electrode for the outside shielding of the outside electrode.

And, It is desirable to withdraw the connection terminal for the electrical wiring of said inside electrode and outside electrode to the outer face of outside electrode plate by the terminal passing through said outside electrode plate
15 electrically.

It is desirable to coat the quality of Teflon for reducing of an adhesive force by said liquid dielectric as same as the thermostatic type mineral oil that the coefficient of a loss and the oil characteristics are very excellent and it has a very little influence by the temperature to both faces of said inside electrode
20 plate and the inner face of said each a outside electrode plate.

It is desirable to pour said liquid dielectric to the space that is formed to the inside electrode plate and the outside electrode and the metal ring for

supporting of the electrode up to 50% rate.

Disclosure of Invention

5 The above object and advantages of the present invention will become more apparent by describing in detail-preferred embodiments thereof with reference to the attached drawings in the following.

 The measured electric capacity value must be increased for decreasing of the entire size and for increasing of the measuring sensibility of the inclination
10 sensor. That is to say, if the electric capacity is increased, the reactance is decreased therefore it becomes to be caused the increasing of the measuring electric current in the bridge circuit.

 Also, it must be manufactured as the complete shielding structure for composing of the electric capacitance that the reappearing nature and the
15 stability are very excellent and also that it is possible to remove an electric resistance that is added by the outside, and it must make use of the liquid dielectric that the oil characteristics is very excellent.

 In the present invention as shown in Fig.1 and Figs. 2a and 2b, it places the inside electrode plate 1 on the center of the metal ring 3 for supporting of
20 the electrode by putting and fixing of the irregular part of the inside electrode place 1 that has the inside electrodes 11a, 11b, 16a and 16b divided into semicircular type to both faces to the irregular groove 33 of the metal ring (3). Of course, it places to be formed the designated space as same as the

circulation road 31 of the dielectric between the inside face of the metal ring 3 for supporting of the electrode and the irregular part of inside electrode plate 1 therefore, when the inclination of apparatus and structure is measured, it becomes to be possible to move the liquid dielectric that is smoothly put
5 between the inside electrode plate 1 and outside electrode plates 2 and 4.

Specially, the center insulated wire of the inside electrodes 11a and 11b divided to one face of inside electrode plate 1 and the center insulated wire of the inside electrodes 16a and 16b divided to the another face make horizontally or vertically, therefore, it can be possible to use selectively the measuring limits
10 of the inclination into $0^{\circ} \sim 90^{\circ}$ degrees or $0^{\circ} \sim 180^{\circ}$ degrees, etc. by the sensor formed into the inside electrodes 11a, 11b and the outside electrode 24 and the sensor formed into the inside electrodes 16a, 16b and the outside electrode 41. That is to say, it is possible to measure the inclination in horizontal state to $0^{\circ} \sim 90^{\circ}$ degrees by the electric capacity type sensor including the
15 inside electrodes 11a, 11b and outside electrode 24 and also even if the sensor of the present invention is not placed again, it is possible to measure the inclination based on the vertical state to $90^{\circ} \sim 180^{\circ}$ degrees by the electric capacity type sensor including the inside electrodes 16a, 16b and the outside electrode 41 in the present state.

20 Moreover, if the electric capacity type sensor of the present invention in a body is used, it is possible to measure the inclination of apparatus or structure to $0^{\circ} \sim 180^{\circ}$ degrees simultaneously as shown in Fig.12.

And also, as shown in Figs. 3a, 3b, the guard-ring electrodes 13a, 13b that divided with the inside electrodes 11a, 11b, 16a, 16b electrically have been formed to the circumference of the both faces of inside electrode plate 1, the connection terminals 14a, 14b, 15a, 15b that divided with the guard-ring electrodes 13a, 13b electrically are formed to the designated portion of the guard-ring electrodes 13a, 13b, and also they are directly connected by the wire to the inside electrodes 11a, 11b with each other and the electrode surface of the inside electrodes 16a, 16b, therefore it is to remove entirely and to wire and to connect electrically the wire the errors of inclination that is generated by the irregularity of electrode surface. That is to say, it is rightly that the connection terminals 11a, 11b, 16a, 16b are connected to the connection terminals 21a, 21b, 27a, 27b of outside electrode plate 2 because the connection terminals 14a, 14b, 15a, 15b are electrically connected to the inside electrodes 11a, 11b, 16a, 16b from each other and the inside electrodes 11a, 11b, 16a, 16b are wired and connected by the wire to be arranged in a line or to be arranged separately.

Also, if it is necessary to measure more precisely the inclination in a direction to 0° ~ 90° degrees than the measuring limits of the wide inclination, it is necessary to divide the inside electrode for harmony between the inside electrodes 11a, 11b that formed to the both faces of inside electrode plate 1 and the center insulating wire of the inside electrodes 16a, 16b from each other

and also it can be possible to improve the electric capacity in duplication by connecting in a line of the connection terminals 14a, 14b, 15a,

15b with them form each other.

As shown in Fig.1 through Fig. 4, the outside electrode plates 2, 4 are fixed after connecting of the outside electrode plates 2, 4 to the metal ring 3 for supporting of the electrode, and then the metal ring 3 for supporting of the electrode, and then as shown in Figs. 5a, 5b and Figs. 6a, 6b, the outside electrodes 24, 41 are formed to the fixed projections 32a, 32b formed to both sides of the metal ring 3 for supporting of the electrode in a cylindrical shape having the metal band 29 rebooted for connecting of the connection electrodes 25, 43 for the voltage regulator shielding of the outside electrode plates 2, 4 electrically, and then the outside electrode plates 2, 4 formed by the guarding-ring electrodes 22, 42 divided electrically are connected to the circumference.

The connection terminals 21a, 21b, 23, 27a, 27b, 44 separated electrically with the guard-ring electrodes 22, 42 are formed to the designated portion of said guard-ring electrodes 22, 42, and the connection terminals 21a, 21b, 23, 27a, 27b, 44 are connected with the outside of the outside electrodes 2, 4 through the passing hole (i.e. this is to say the state that the metal passing through the electric inner the hole bored by PCB, and it has a characteristics that it can solder very strongly because it is solder since the wire has been put into the through hole when the wire is electrically connected with the connection terminal) that passes through the outside electrode plate 2 electrically. Here, the connection terminals 21a, 21b among a plurality of connection terminals are electrically connected with the inside electrodes 11a, 11b and the connection

terminals 27a, 27b are electrically connected with the inside electrodes 16a, 16b and the connection terminals 23, 44 are electrically connected with the outside electrodes 24, 41 electrically from each other.

Also, it is possible to intercept the outflow of the liquid dielectric
5 because the O-ring 28 is indwell between the fixed bands 32a, 32b of metal ring 3 for supporting of the electrode and each outside electrode plates 2, 4.

And also, the grounding electrodes 25, 43 for the voltage regular shielding has been formed to the outer circumference of circle of outside electrode plates 2, 4, and as shown in Fig. 2a, the metal band 29 formed to both
10 faces of the metal ring 3 for supporting of the electrode is projected to the inner portion and connected to the grounding as the metal ring 3 for supporting of the electrode with the grounding electrodes 25, 43 for the voltage regular shielding of inner circumference of circle. Accordingly, the electric capacity formed between the inside electrode and outside electrode is not affected by the
15 electric field or the noise, etc. being added from the outside.

Here, for generating of the difference of the electric capacity in two couple of electric capacitor by the outflow of the liquid dielectric 5 injected between the inside electrodes 11a, 11b, 16a, 16b and the outside electrodes 24, 41, the liquid dielectric must have the characteristics as follows.

20 The first, the loss factor must be smaller than 10^{-4} , and second, the corrosiveness against the metal must be not exist, third, the viscosity for the smooth flowing must be low, fourth, the cohesive power of the liquid itself must

be bigger than the adhesive power with the electrode surface.

As the liquid dielectric 5 proper for the necessary condition as above, there is the thermostatic mineral oil and it is possible to ignore the balance control of conductance completely at the time the electric capacity is measured
5 by such a liquid dielectric 5.

More particularly, if the liquid dielectric 5 proper against the capacity of inner space formed between the inside electrode 1 and the outside electrode plates 2, 4 after framing of the inside electrode plate 1 and the outside electrode plates 2, 4 is injected through the injection tool formed to the metal ring 3 for
10 supporting of the electrode, as shown in Fig. 10, it is possible to extend the measuring limits of inclination increased to $0^{\circ} \sim 90^{\circ}$ degrees. On the other hand, if the amount of liquid dielectric 5 is injected fewer than the optimum condition amount, it becomes to be not obtained by the characteristic of the straight line in around of 90° degree.

15 Fig.10 shows the test result to which decide the optimum condition amount, it can be known that 1.6 μl is the best suitable size. That is to say, if the liquid dielectric 5 is injected to the space coming under 50% of the inner space formed between the inside electrodes 11a, 11b, 16a, 16b and the outside electrodes 24, 41, it is possible to measure the best of measuring value.

20 It has been coating by the quality as Teflon, etc. for increasing of the cohesive power of liquid dielectric itself than the adhesive power of liquid dielectric 5 to the inside electrodes 11a, 11b, 16a, 16b as above and the face of

outside electrodes 24, 41. Accordingly, it is because it becomes to be the main error at measuring of the inclination if the adhesive power of liquid dielectric 5 is bigger than the cohesive power, it comes back into the original place since a body of sensor is shaken or rotated thereafter, the water drops of liquid dielectric 5 are stuck on the inside electrodes 11a, 11b, 16a, 16b and the surface of outside electrode 24, 41.

The inclination sensor that one of inside electrodes 11a, 11b, 16a, 16b is drawn horizontally and the another is vertically equipped according to the structure and the installation method of inside electrodes 11a, 11b, 16a, 16b can measure the inclination (angle) in the limits of maximum 0° ~ 180° degrees into the resolution of 0.1° or 0.01° and can be useful to measuring of inclination of given apparatus or equipment, etc. and also to monitoring continuously of inclination according to the used object and the equipped space.

Brief Description of the Drawings

Fig. 1 shows an exploded perspective view showing the present invention.

Figs. 2a and 2b show a sectional view showing the present invention.

Figs. 3a and 3b show the front and rear views showing the inner electrode plate depicted in Fig. 1.

Fig. 4 shows a cutting perspective view showing the metal ring for

supporting an electrode depicted in Fig. 1.

Figs. 5a and 5b show the front and rear views showing the outside electrode plate as an example depicted in Fig. 1.

5 Figs. 6a and 6b show the front and rear views showing the outside electrode plate as another example depicted in Fig.1.

Figs. 7a and 7b show the schematic diagram showing the state of liquid dielectric of the inner portion of sensor in such cases that the inclination is 0° or the other.

10 Fig. 8 shows a schematic diagram to explain such a case that the sensor is installed vertically according to the present invention.

Fig. 9 shows a schematic diagram to explain such a case that the sensor is inclined and installed into a side surface according to the present invention.

15 Fig.10 shows a graph showing the changes of the electric capacity per the inclination of the sensor according to the amount of liquid dielectric depicted in the present invention.

Fig.11 shows a graph showing the analysis results of characteristic within the limits of $0^\circ \sim 90^\circ$ of the sensor according to the present invention.

20 Fig.12 shows a graph showing the analysis results of characteristic within the limits of $0^\circ \sim 90^\circ$ of the sensor according to the present invention.

Fig.13 shows a circuit diagram to explain such an example that measured the inclination by a sensor according to the present invention.

Description of the preferred embodiments

The inclination sensor as shown in Fig.1 through Figs.2a, 2b, is same
5 with Figs. 7a, 7b showing the operating principle of the inclination sensor.

First, it composes of a couple of electric capacitor by the inside and the
outside electrode 24 faced and equipped with it and also it composes of another
couple of electric capacitor by the inside electrodes 16a, 16b and the outside
electrode 41 faced and equipped with them. Of course, the liquid dielectric 5
10 must be poured between the sealed inside electrodes 11a, 11b and the outside
electrode 24 and another inside electrodes 16a, 16b and the outside electrode
41 by the metal ring for supporting of the electrode.

If the inclination sensor as shown in Fig.7a is left to be become the
insulating center line of the inside electrodes 11a, 11b into the vertical state, the
15 difference of electric capacity of both electric capacitors becomes as zero.

But, if the inclination sensor as shown in Fig. 7b, that is to say, the insulating
center line of the inside electrodes 11a, 11b is inclined, the surface size of the
inside electrodes 11a, 11b including the liquid dielectric is different, therefore,
the difference of electric capacity of both electric capacitors is increased.
20 Accordingly, the difference of electric capacity is increased by the size of
inclination and the difference of electric capacity is maximum when the
inclination becomes 90° degree.

Fig.10 is the result measuring and giving an analysis of the characters of the inclination sensor using the measuring principle and this is to compare the relationship of the actual mechanical inclination and the difference of measured electric capacity by the graph. This is showing to measure the inclination by the change of electric capacity more precisely.

That is to say, as shown in Fig. 9, even if the inclination is inclined into the side because the space of oad and the space of obc are offset each other, it is not given an influence with the measuring result.

The operating of inclination sensor as shown in Fig.13, the difference of electrode capacity is generated by the flowing of liquid dielectric because the designated input added by the oscillator 400 is connected to the electric capacity at the trans former 300, and also it is possible to indicate the size into the indicating value of the digital or the analog, etc. according to the object by the electric circuit portion 200 (it is the value permitted by the sensor 100 and it is referred to the circuit for calculating of the inclination), or it is possible to indicate the designated inclination into the sound or stick graph, etc.

Effects of the Invention

Also, the present invention is possible to measure the inclination of apparatus or structure, etc. based on the changes of electric capacity between the inside electrode and the outside electrode due to the flowing of the liquid type dielectric according to the inclination by a sensor composed as a couple of

semicircular type inside electrode and the outside electrode faced with it and the liquid type dielectric having the best characteristics.

Also, the present invention has an effect which possible to measure the measuring limits of the inclination of apparatus or structure into $0^\circ \sim 90^\circ$ degrees, $90^\circ \sim 180^\circ$ degrees, or $0^\circ \sim 180^\circ$ degrees, etc. by dividing of both
5 of the inside electrodes each other vertically and/or horizontally included in the inclination sensor.

Also, the present invention has a characteristic which possible to measure the inclination of apparatus or structure, etc. because the changes of
10 electric capacity between the inside electrode and the outside electrode are intercepted by intercepting of the noise of electromagnetic force or the changing factor of electric field completely.

And, the present invention has an effect which possible not only to indicate the size of inclination of apparatus or structure, etc. into an analog or
15 the digital by changing of the electric capacity but also to indicate the designated inclination (angle) into the sound or the stick graph, etc.

Industrial Applicability

20 The present invention as mentioned in above, it is possible to measure the inclination of apparatus or structure, etc. based on the changes of electric capacity between the inside electrode and the outside electrode due to the flowing of the liquid type dielectric according to the inclination by a sensor

composed as a couple of semicircular type inside electrode and the outside electrode faced with it and the liquid type dielectric having the best characteristics.

Accordingly, if the horizontal state of apparatus or structure, or the state
5 of inclination is exactly measured, the applicable field is very abroad. It is needed to maintain always any angle for the structure because it is over such a simple category that the horizontal state of the plate or mechanism is simply measured, or the horizontal or vertical state of a building is simply measured and also every kind of industrial field are becoming very variously, highly and
10 precisely. Also, it is continuously increasing such a field that measure the inclination state of the apparatus or structure that is changed at any time. At this time, if the sensor exists for changing the result measuring of the inclination into the electronic signal, it will be very usefully used.

Also, it is obvious that this dealer can change or correct variously the
15 present invention in the limits of technical idea and also, it stands to reasons that the variation or correction is belonged to the claims attached.

What is claimed is:

1. The capacitive sensor for measuring of the inclination of which is
5 possible to measure the horizontal state or the inclination of the apparatus and
structure, etc, and more particularly, of which is possible to measure the
inclination based on the changes of the electrode area that the liquid type
dielectric is contacted between inner electrode and outer electrode by the
inclination since the sensor is composed by pouring the liquid type dielectric
10 between the inner electrode that is divided into a couple and the outer electrode
that is facing with the inner electrode composing;

the metal ring for supporting of electrode of circular shape, and

the inside electrode plate that is vertically fixed in the length direction of
said metal ring for supporting of electrode, and also that the semicircular type
15 inside electrode of which is divided into each a couple is formed to the center of
said metal ring for supporting of electrode each other;

the outside electrode plate that is distantly and separately fixed to both
faces of the metal ring for supporting of said electrode in the designated
distance from each other, and also that the outside electrode has been formed
20 to the inside face; and

the liquid type dielectric to which is inflow to the space between the
inside electrode plate sealed by the metal ring for supporting of the electrode
and the outside electrode plate.

2. The capacitive sensor for measuring of the inclination according to claim 1 wherein,

the inside electrodes of both faces of said inside electrode plate are crossed directly and divided with each other because there is the state that the inclination of 0° ~ 90° degrees is measured by the inside electrode of one side of said inside electrode plate and one of out side electrode of which is facing with the inside electrode and it can be possible to measure the inclination of 90° ~ 180° degrees by the inside electrode of the others face of said inside electrode plate and the others outside electrode which is facing with the inside electrode.

3. The capacitive sensor for measuring of the inclination according to claim 1 wherein,

the measuring sensitivity is increased in duplication because the inside electrode of both faces of the inside electrode plate are symmetric and divided to be corresponded with each other, and also the inside electrode of both faces of said inside electrode plate is contacted to be lined up with each other, therefore it is possible to measure the inclination of 0° ~ 90° degrees in duplication.

4. The capacitive sensor for measuring of the inclination according to claim 1 wherein,

the inside electrode plate is combined with the metal ring for supporting of electrode that a plurality of irregularities portion is formed to the outer

circumference face of inside electrode plate, and the designated space is formed for moving of the liquid dielectric between the metal ring for supporting of the electrode and the essential part of inside electrode plate.

5 5. The capacitive sensor for measuring of the inclination according to claim 1 wherein,

the guard ring electrode that is disconnected with the inside electrode and the outside electrode is formed to the both faces of the inside electrode plate and the circumference of inside face of the outside electrode plate.

10 6. The capacitive sensor for measuring of the inclination according to claim 1 wherein,

the connecting terminal for the electrical connection of the inside electrode and the outside electrode is electronically connected to the back of each a electrode plate through the through hole passing through the inside electrode plate and the outside electrode plate.

15 7. The capacitive sensor for measuring of the inclination according to claim 1 wherein,

the metal ring for supporting of the electrode and the connection electrode for the voltage regulator shielding are electrically connected by rebating of the metal band after forming the connection electrode for the voltage
20 regular shielding to the outside face of the outside electrode plate and fixing the outside electrode plate to the metal ring for supporting of the electrode.

8. The capacitive sensor for measuring of the inclination according to

claim 1 wherein,

the three-terminals type electric capacitor is electrically accomplished by connecting of the guard ring connection electrode of both faces of the inside electrode plate and the outside electrode plate with the grounding connected to
5 the metal ring for supporting of the electrode.

9. The capacitive sensor for measuring of the inclination according to claim 1 wherein,

the quality of Teflon is coated for reducing of the adhesive force with each a electrode surface and the liquid type dielectric to the both faces of the
10 inside electrode plate and the inside face of each a outside electrode plate

10. The capacitive sensor for measuring of the inclination according to claim 1 wherein,

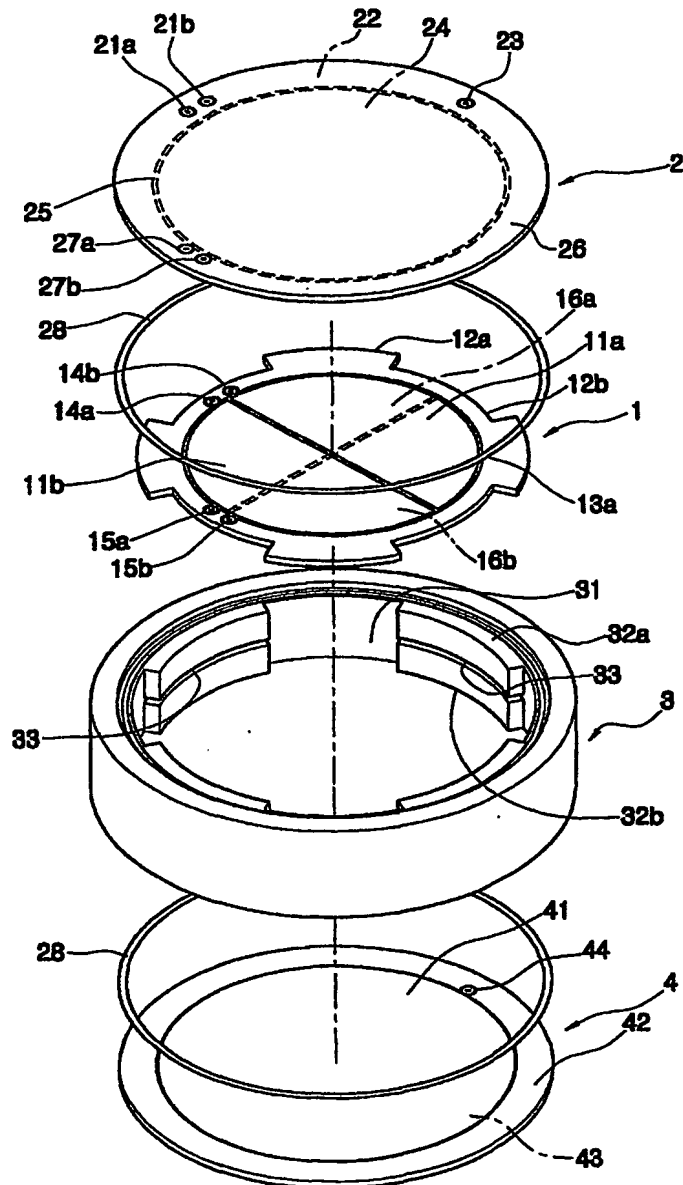
the liquid type dielectric is the thermostatic type mineral oil.

11. The capacitive sensor for measuring of the inclination according to
15 claim 1 wherein,

the liquid type dielectric is poured to the space that is formed by the inside electrode plate and the outside electrode plate and the metal ring for supporting of the electrode up to 50% rate.

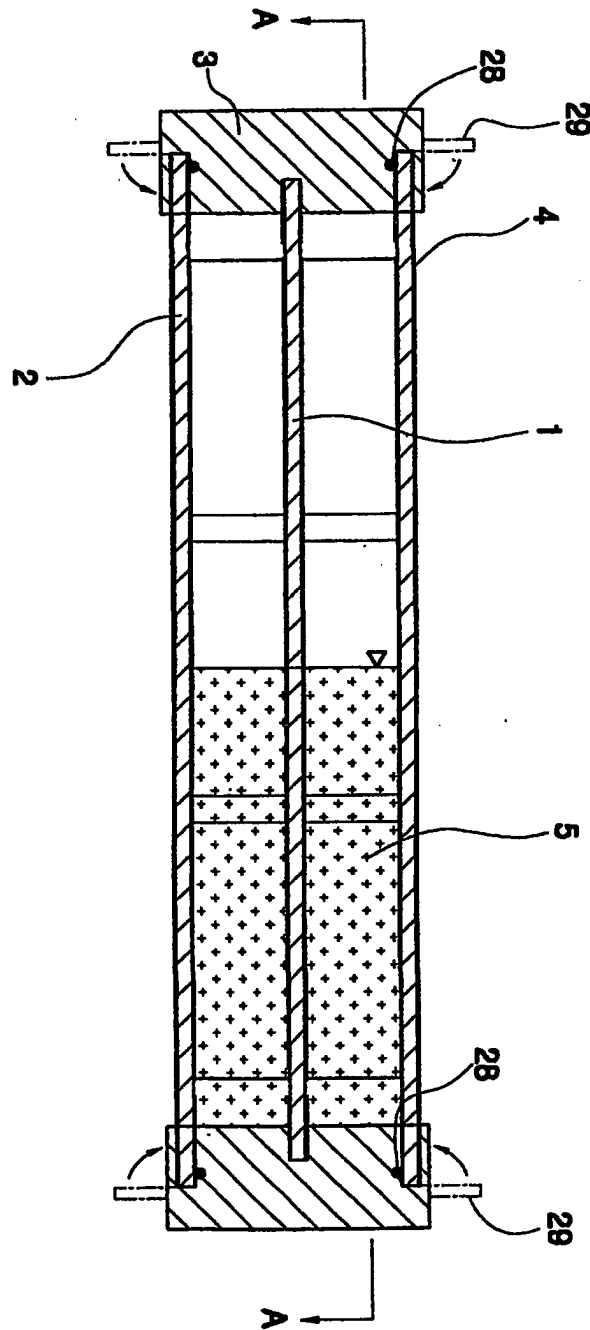
1/18

FIG.1



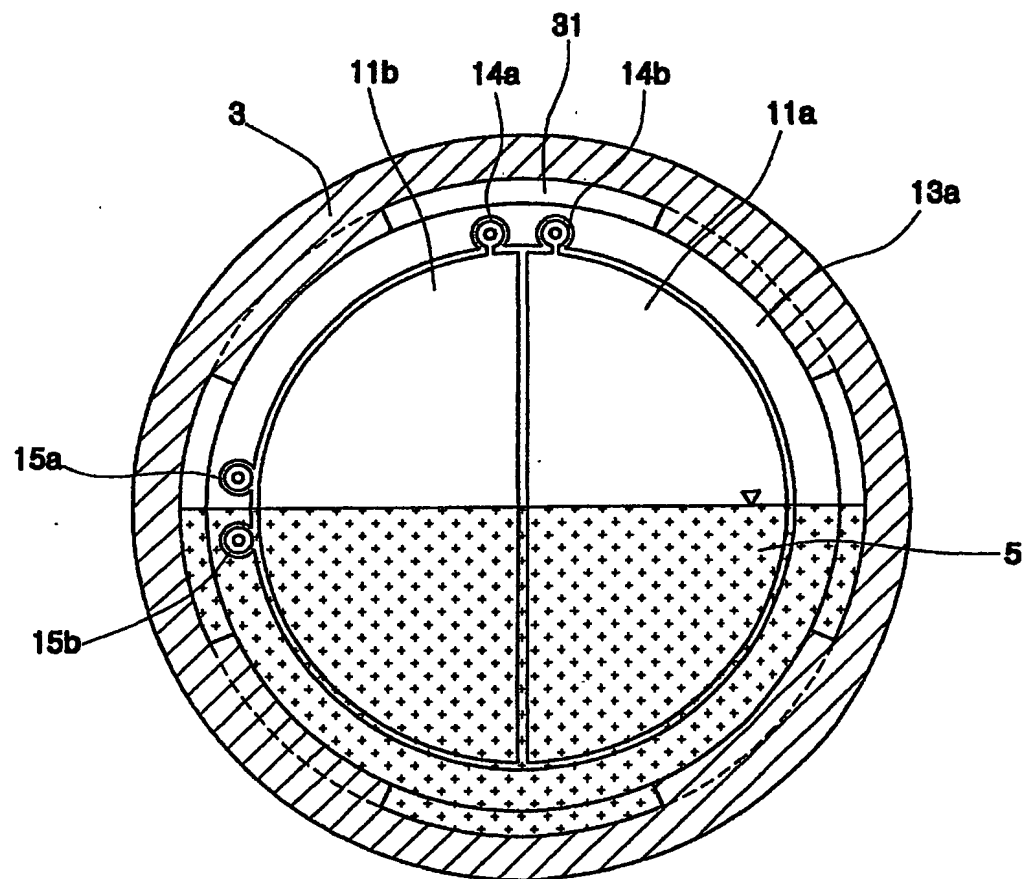
2/18

FIG.2a



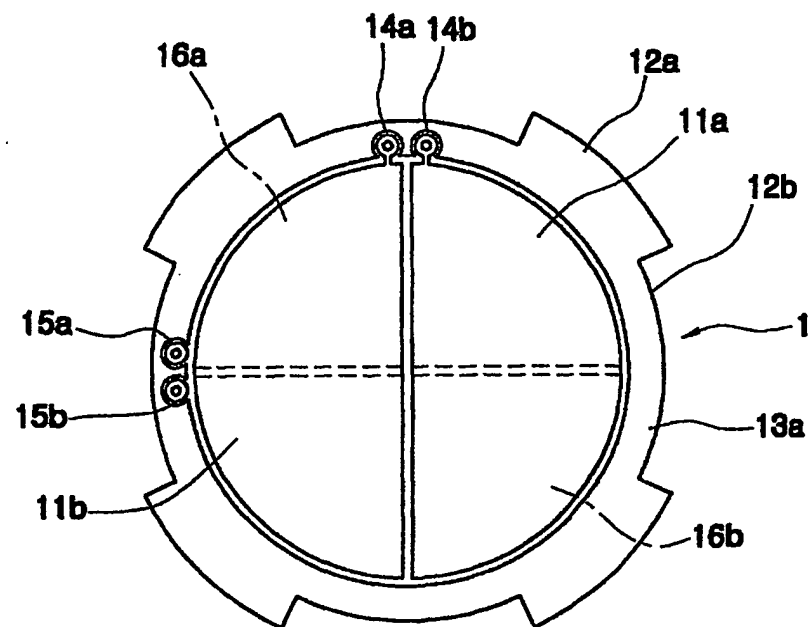
3/18

FIG.2b



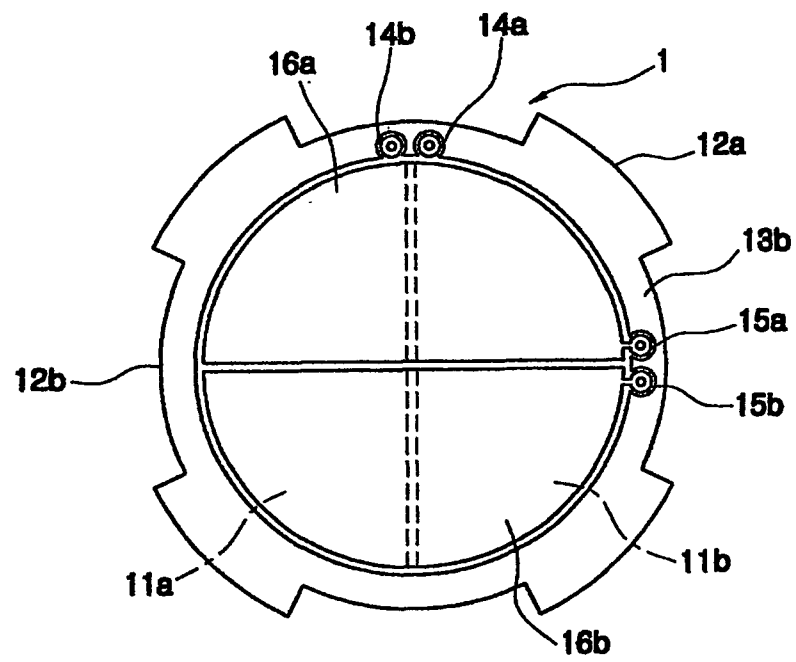
4/18

FIG.3a



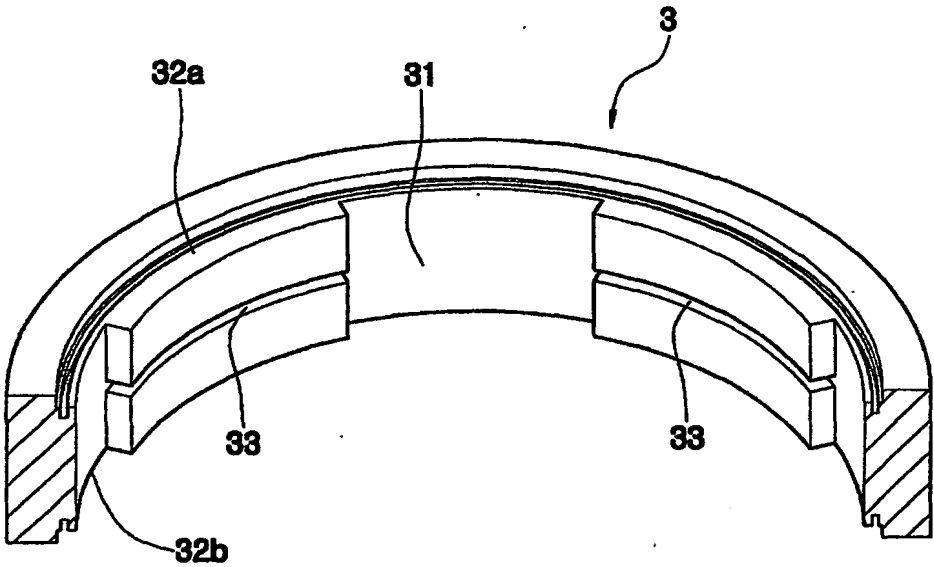
5/18

FIG.3b



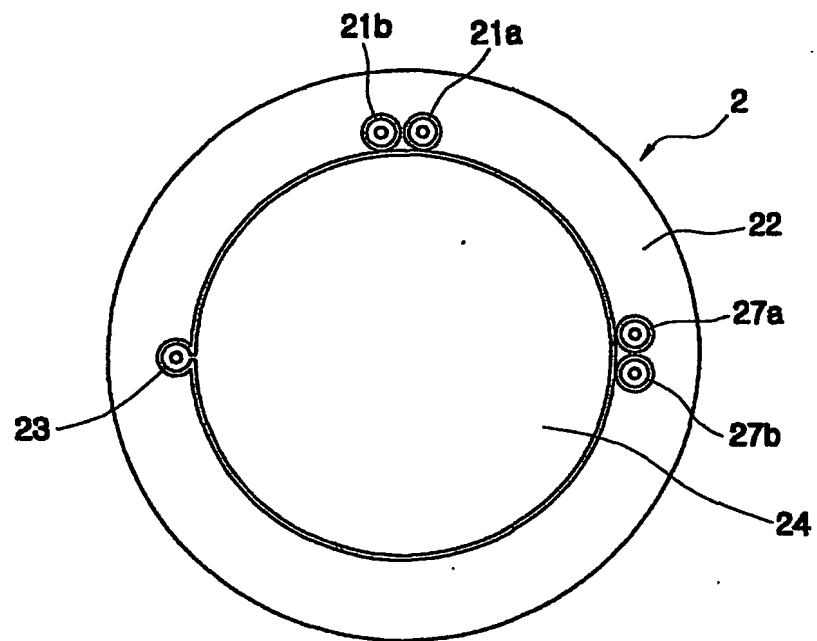
6/18

FIG.4



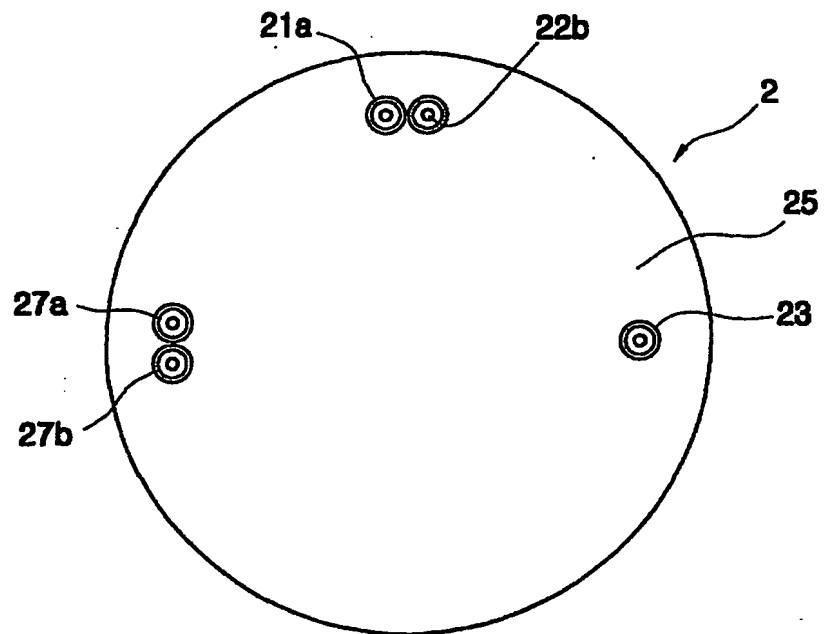
7/18

FIG.5a



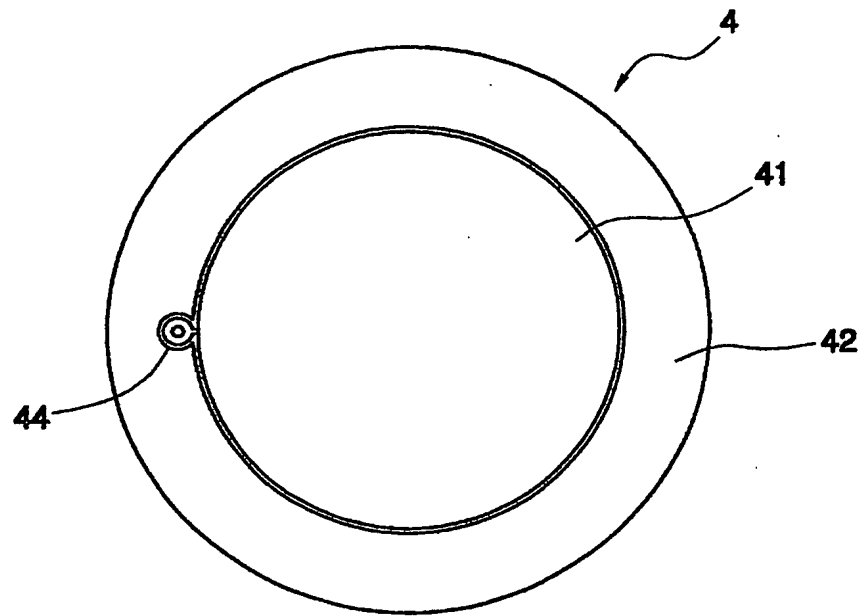
8/18

FIG.5b



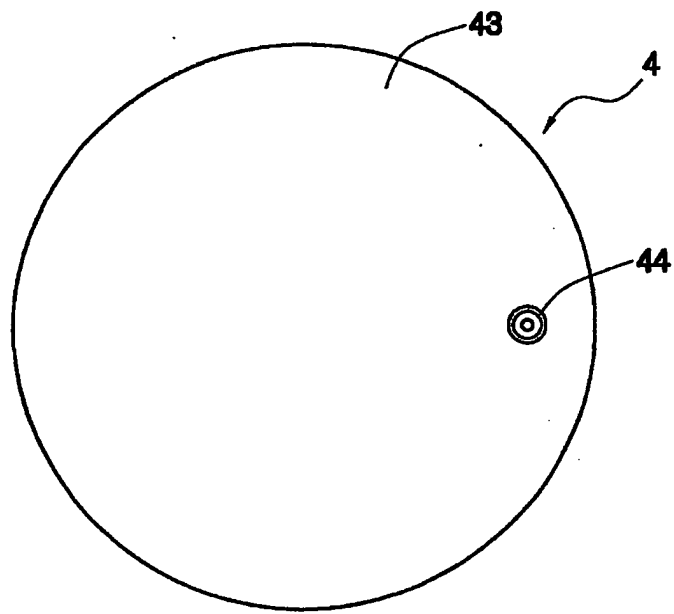
9/18

FIG.6a



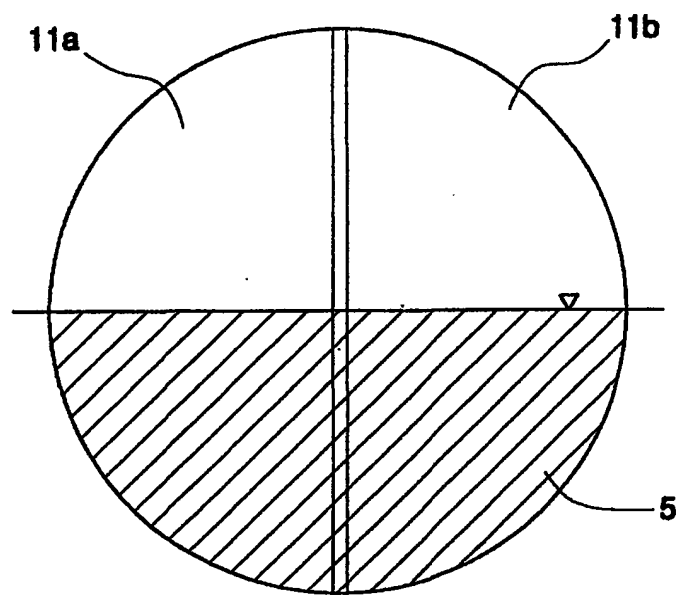
10/18

FIG.6b



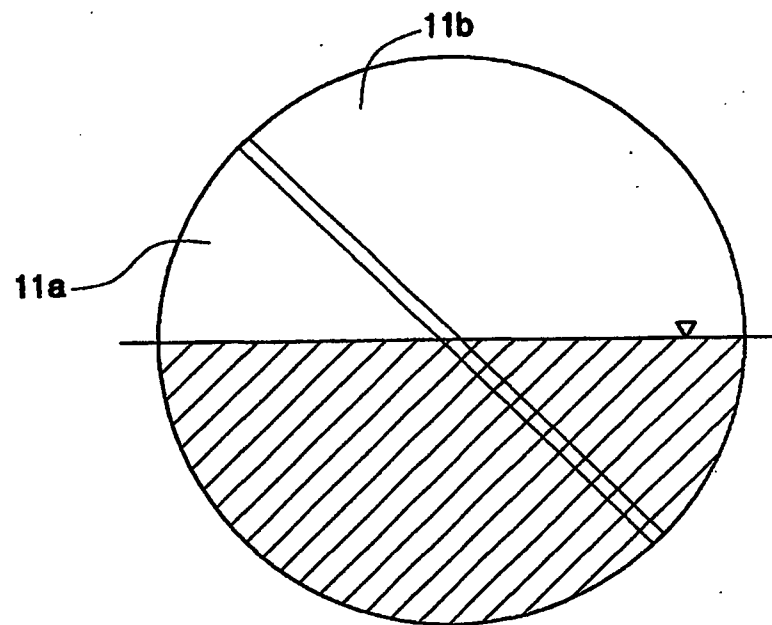
11/18

FIG.7a



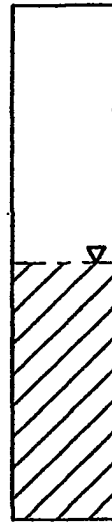
12/18

FIG.7b



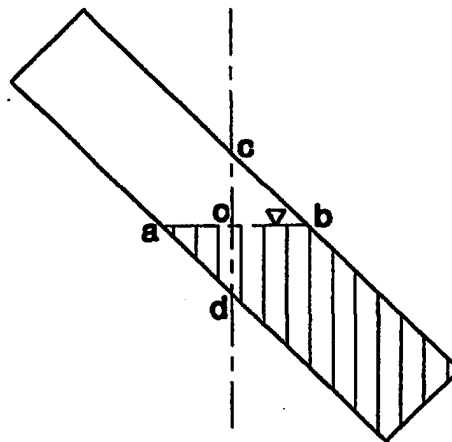
13/18

FIG.8



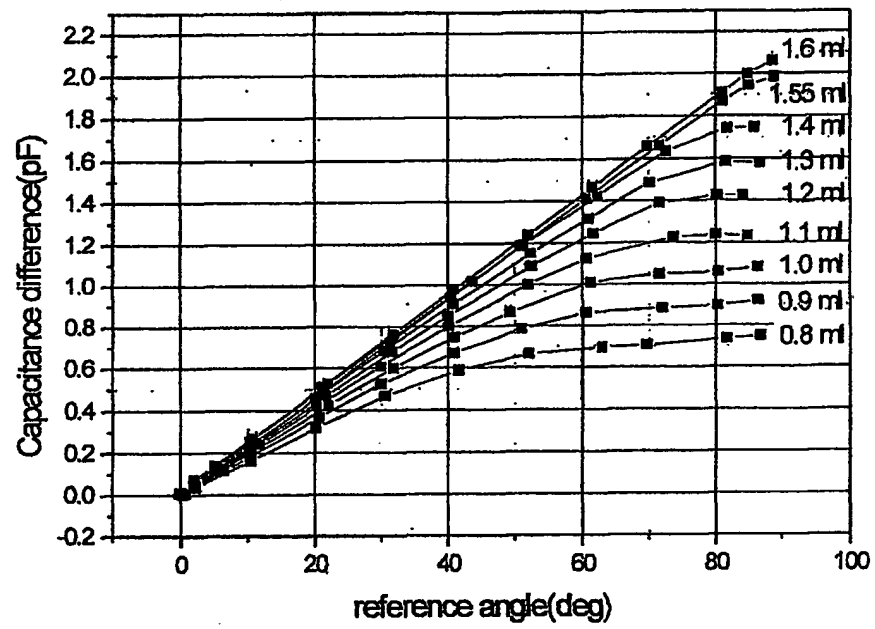
14/18

FIG.9



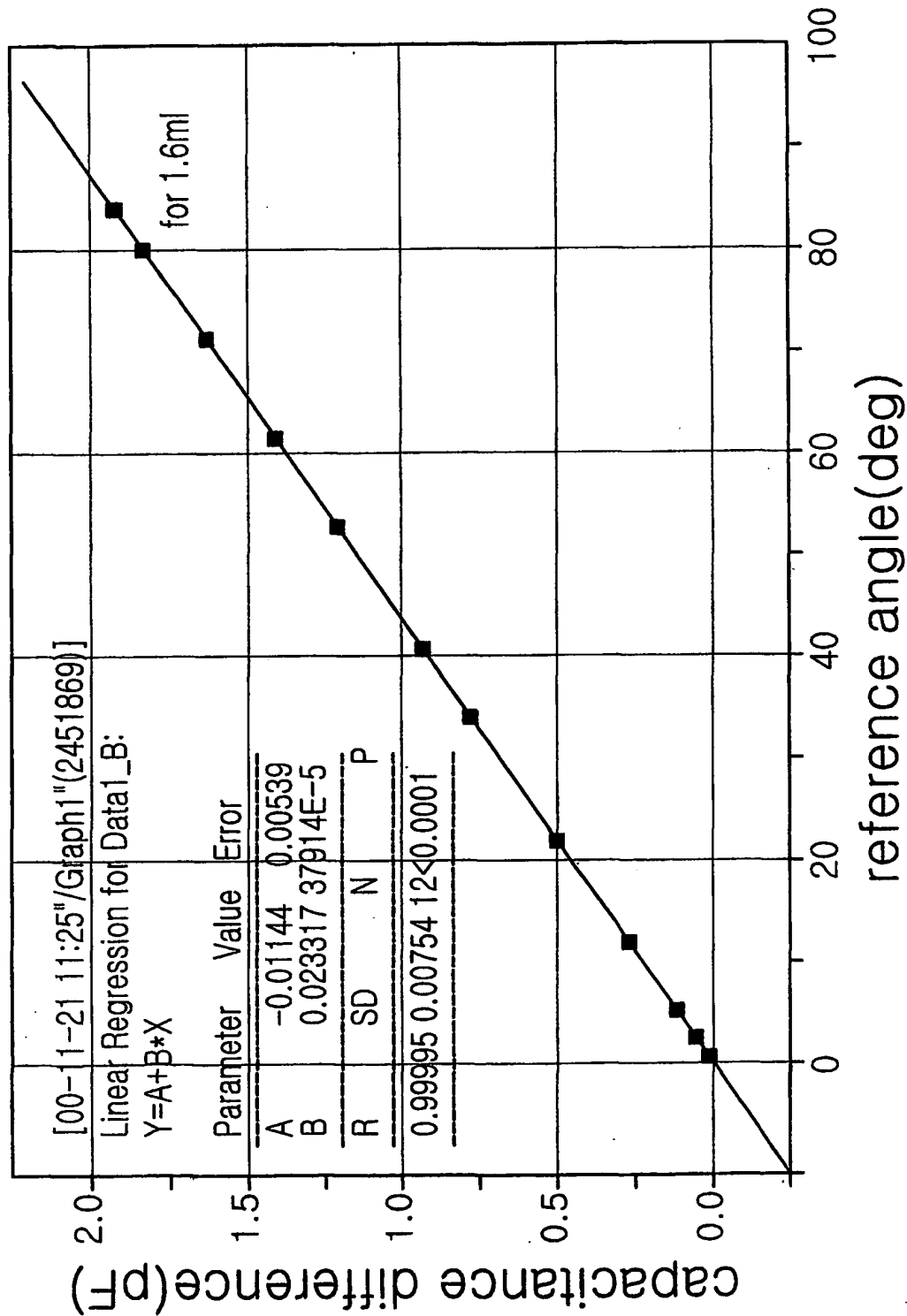
15/18

FIG.10



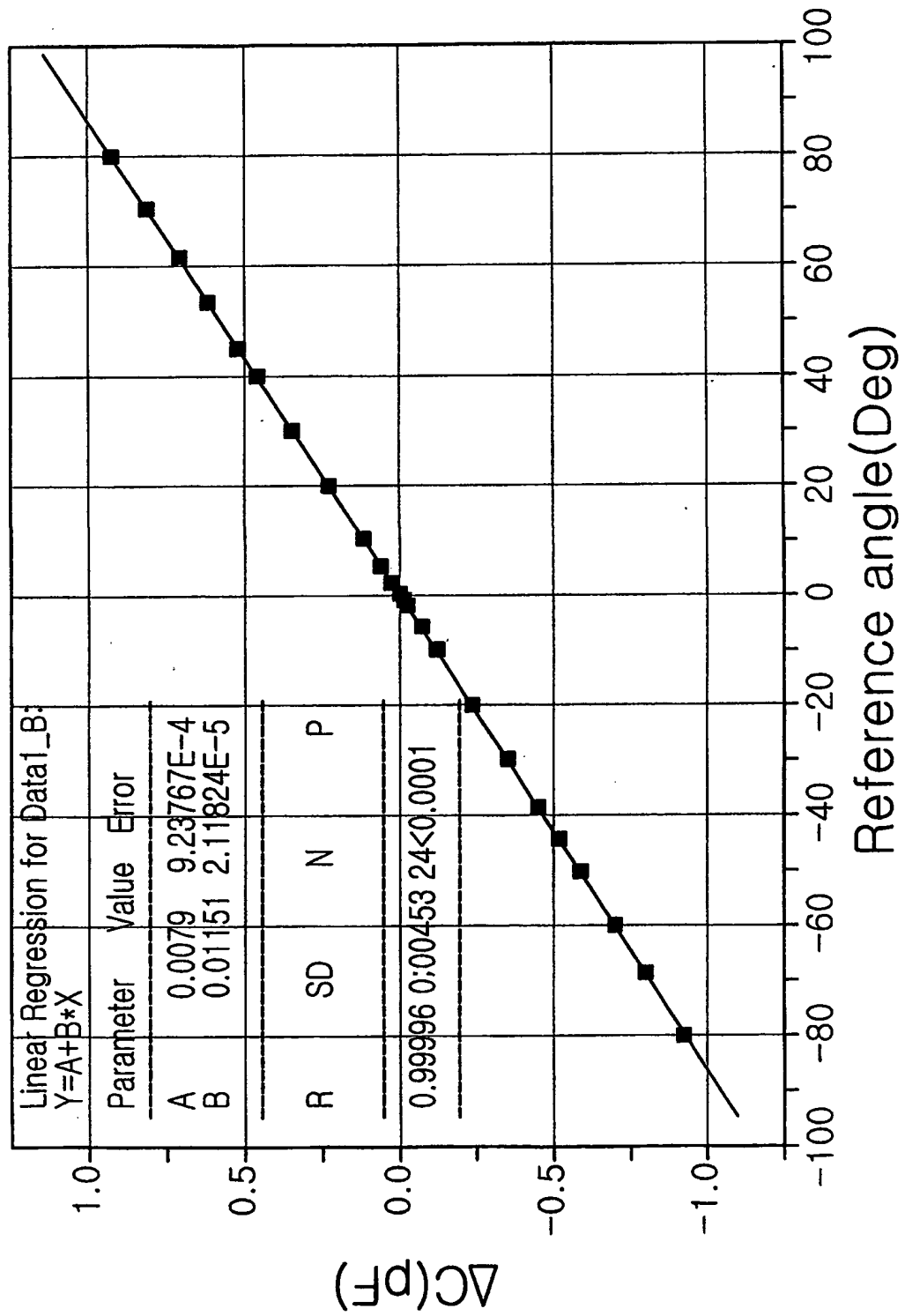
16/18

[도 11]



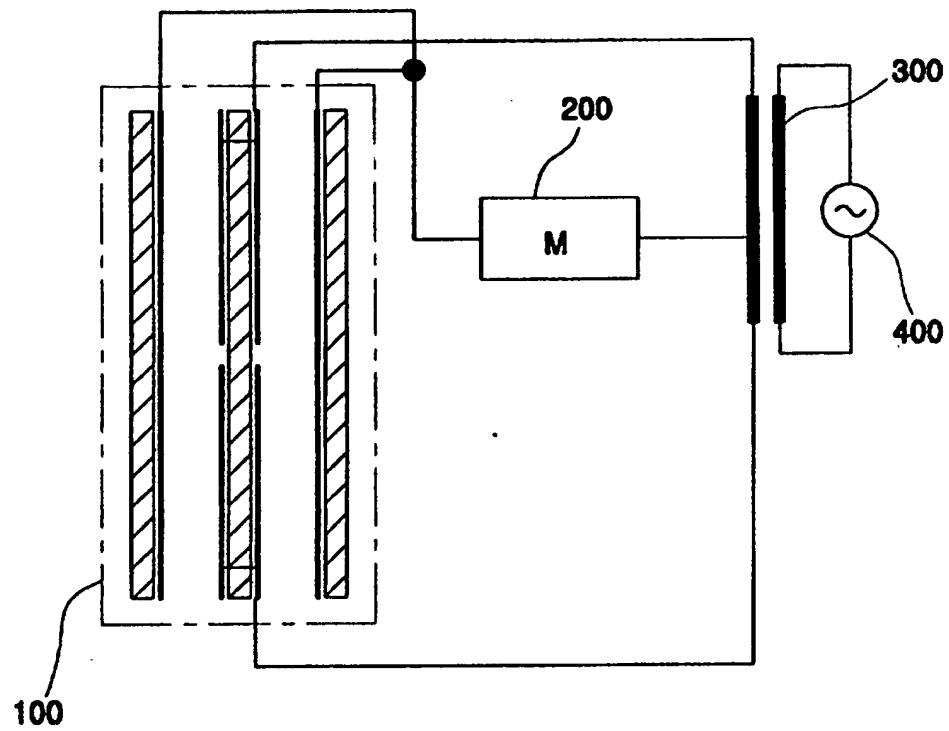
17/18

[도 12]



18/18

FIG.13



A. CLASSIFICATION OF SUBJECT MATTER**IPC7 G01C 9/18**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7 G01C 9/00, 9/22, 15/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Patents and applications for inventions since 1975

Japaneses Utility models and application for Utility Models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EDOC, APS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5170567 (DAVIS. et al.) 15 DECEMBER 1992, see the whole Document	1-3, 9-11
Y	WO 97/49973 (ELIYASHEV, Dmitry Edgarovich) 31 DECEMBER 1997, see the Claims	1-3, 9-11
A	JP 10-227637A (MIYAUCHI NORIO) 25 AUGUST 1998, see the whole Document	1-11

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

13 AUGUST 2002 (13.08.2002)

Date of mailing of the international search report

13 AUGUST 2002 (13.08.2002)

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
920 Dunsan-dong, Seo-gu, Daejeon 302-701,
Republic of Korea

Authorized officer

KONG, In Bok

